METHOD FOR ROBOTICALLY APPLYING LARGE VOLUMES OF STRUCTURAL FOAM WITHIN AUTOMOTIVE APPLICATIONS

TECHNICAL FIELD

The present invention relates generally to robotic devices and more particularly to a method of robotically applying large volumes of structural foam within automotive applications.

BACKGROUND

In recent years, the automobile industry has attempted to improve the soundproof property of the riding space while maintaining handling, drivability and durability of the vehicle. In order to achieve these requirements, demands have been made to provide to provide the rigidity and the soundproof property to a variety of areas where loads are imposed.

It has been suggested that one method for increasing the rigidity of the vehicle body is to introduce a two-component (also known as a two-pack or 2K) foam into a closed section of the vehicle's pillars.

Various problems, however, are inherent in currently available technologies or may result by injecting the two-component foam composition into the closed sectional structure. For example, while low volume dispensing of two-component mixtures is well known, there is no known process capable of injecting the foam at a sufficient rate and volume into a vehicle structure with numerous openings that ensures that the cavities are completely filled.

Further, while manual dispensing of higher volume mixtures is also well known, there is no known automated processes that successfully and accurately dispenses high volumes of foam at a high flow rate.

SUMMARY OF THE INVENTION

The present invention addresses some of the problems listed above by providing an innovative robotic foam application process that integrates system communications, non-contact vehicle insertion point locations, and applications controls to accurately dispense a two-component epoxy foam at a high volume and flow rate.

The process begins by first inserting a baffle structure into inner and/or outer structure openings during pillar fabrication. Each baffle is error proofed to assure presence and proper fabrication. After body assembly, the vehicle is processed through an electrocoat system. During electrocoat bake, the baffles expand and seal cavity openings. Miscellaneous plugs, grommets, and tape are installed over the remaining cavity holes on the sealer deck. After complete processing, the vehicle enters into a structural foam injection cell. Upon entry into the cell, a three-dimensional vision system is used to locate each fill position. A hydraulic driven robotic dispensing system equipped with a high-pressure static mixer injects a high volume of mixed two-component viscous fluid material within each of the respective located fill positions using an anti-drool nozzle. After and during dispensing, the material undergoes an exothermic reaction ("curing reaction"). At the same time, the material is also expanded ("foamed") to substantially fill its respective cavity.

Other objects and advantages of the present invention will become apparent upon considering the following detailed description and appended claims, and upon reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a vehicle support structure;

FIG. **2** is a section view of a portion of the D-Pillar of FIG. **1**;

FIG. **3** is a close-up section view of a portion of FIG. **1**;

FIG. **4** is a close-up section view of another portion of FIG. **1**;

FIG. **5** is a perspective view of a portion of FIG. **1**;

FIG. **6** is a section view of a portion of FIG. **1**;

FIG. **7** is a perspective view of a robotic high volume foam application device injecting a foam within a portion of FIG. **1**; and

FIG. **8** is a logic flow diagram of the process for injecting foam into a portion of the support structure as shown in FIG. **7**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

The present invention relates to a method for introducing a structural two-component foam material within the structural components of a vehicle using an innovative robotic high volume structural foam process. To help illustrate this process, one proposed use of the present invention is illustrated utilizing the D-Pillar for a sports utility vehicle. As such, the process described below should not be construed to be limited to the D-pillar or limited to a sports utility vehicle, but may find wide reaching applications for reinforcing structures within the automotive or other industries.

Referring now to FIG. **1**, a perspective view of a vehicle support structure **10** for a sport utility type vehicle **11** is illustrated as having a pair of A pillars **12**, B pillars **14**, C pillars **16** and D pillars **18** interconnected through a pair of roof side rails **20**, **22** and a pair of bottom rails **24**, **26**.

As best shown in FIGS. **2**–**6**, the D-pillars **18** includes an outer portion **25** and an inner portion **27** coupled together such that a hollow region **29** is formed therein. The D-pillars have a pair of containment baffles **40** sealed to the inner walls **41** of the outer portion **25** and inner portion **27** and that together define a respective upper **28** and lower cavity **30** within the hollow region **29**. As seen in FIGS. **1**–**6**, the outer and inner portion **25**, **27** and baffles **40** contain a layer of electrocoat (shown as **43** in FIG. **2**). The electrocoat **43** functions as a barrier protector and also aids in adhering the baffles **40** to the inner walls **41**.

Each of these cavities **28**, **30** is subsequently substantially filled with foam **78** through a respective fill hole **32**, **34** using a robotic high volume foam application device (shown as **70** in FIG. **76**). The fill holes **32**, **34**, each have a septum **32**A, **32**B that seals around the inserted foam device **70** to prevent the foam **78** from exiting from the respective cavity **28**, **30** during the filling step. The foam **78** is a two-component viscous mixture that exothermically reacts and expands after mixture of the two viscous components and introduction into the cavities **28**, **30**. A vehicle **9** having the foam filled D-pillars **18** as shown in FIGS. **1** and **2** achieves a vehicle torsional stiffness of greater than 20 Hertz, resulting in a 42% increase in static torsional stiffness (a 2 dBA overall on rough road) as compared with similar vehicles not having the foam filling. Vehicles **9** having the foam filled D-pillars **18** also exhibit less squeak and rattle and speech intelligibility.

Referring now to FIG. **7**, the robotic viscous fluid application device **70** comprises a robotic arm **72**. The arm **72** is capable of movement in three-dimensions and is electrically controlled using a robotic controller **74**. The device **70** has